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(56) Documents Cited

**GB 2236591 A EP 0374009 A1 JP 300009794 A**

(58) Field of Search

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**INT CL<sup>5</sup> A47L , D06F**

**Online databases:WPI**

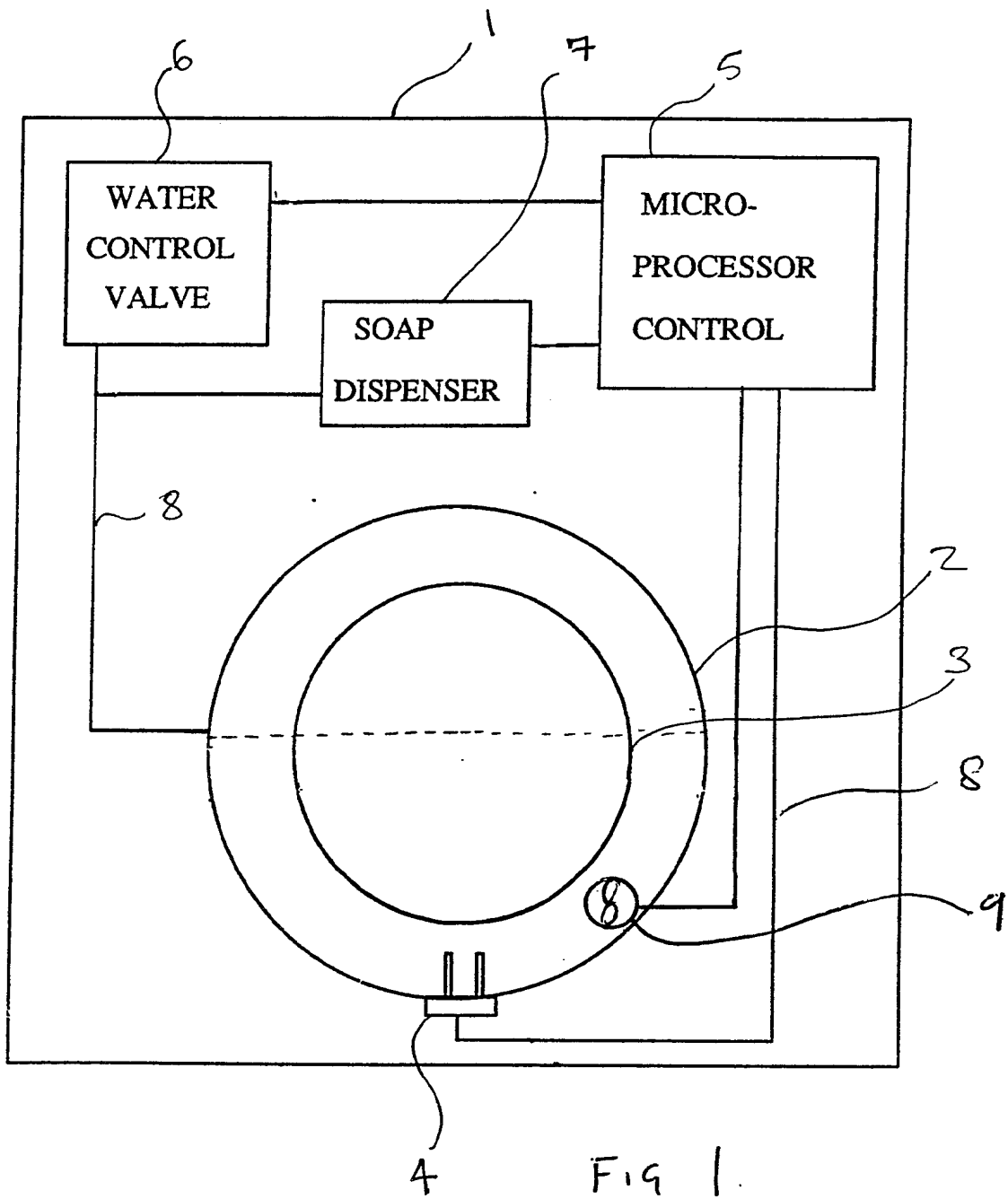
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(54) **Cleaning process controlled in accordance with the density and/or viscosity of the cleaning fluid**

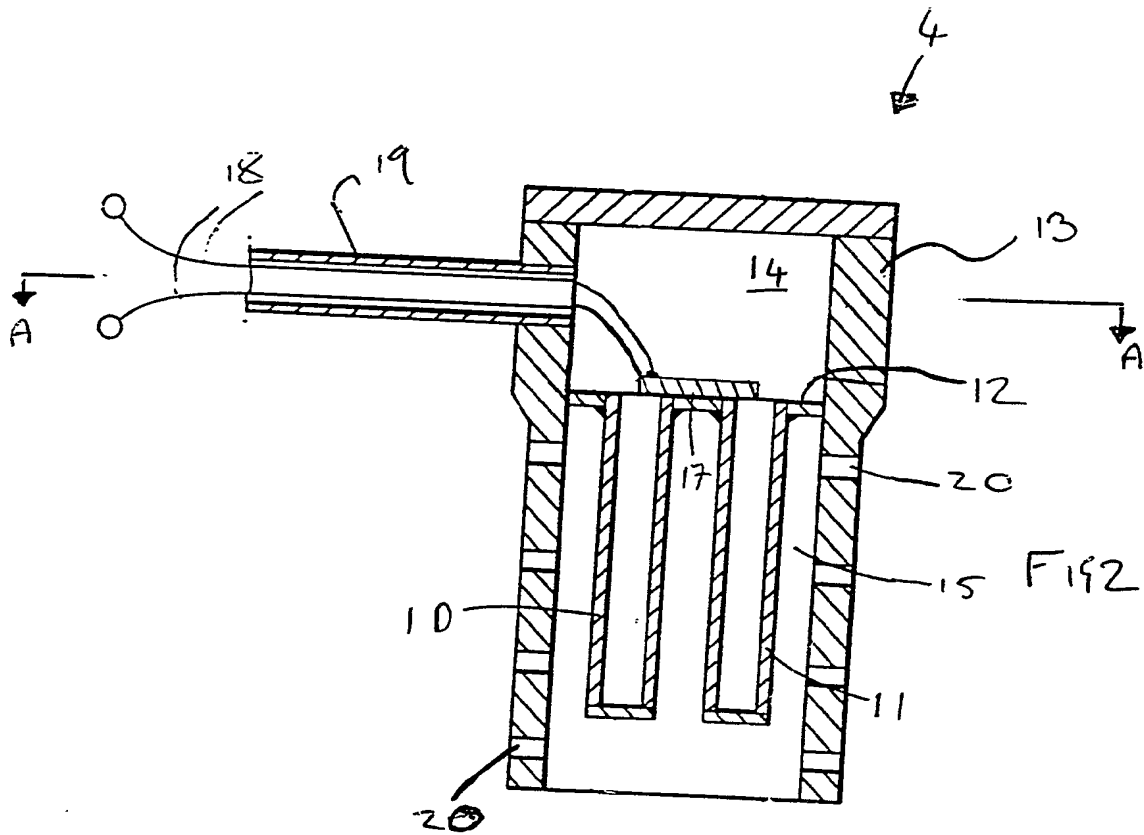
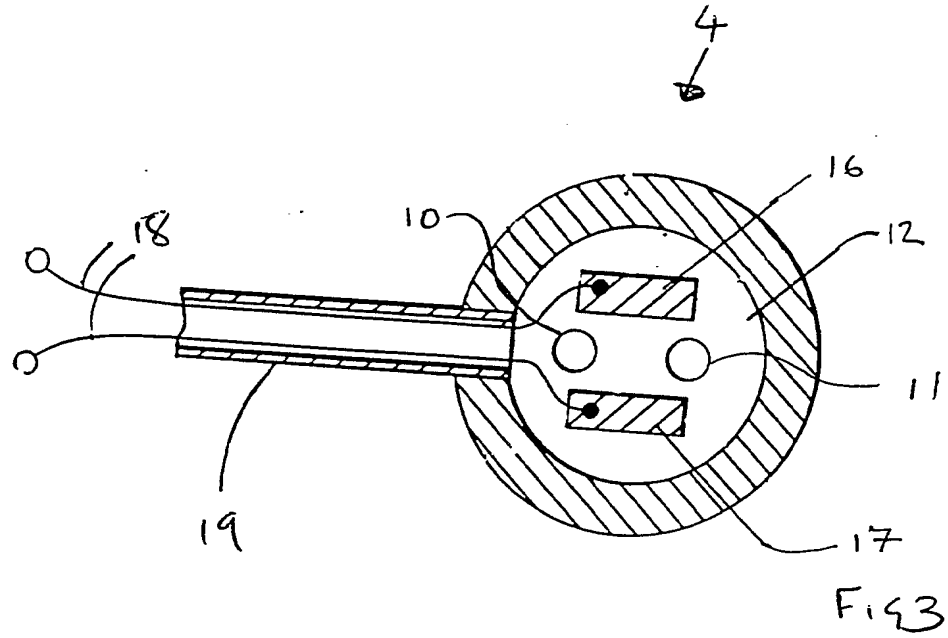
(57) A control system for use in a washing machine in which a liquid cleaning agent is added to material to be cleaned, comprises a sensor for measuring the viscosity and/or density of liquid which has been in contact with the material. The measured viscosity/density is compared with a predetermined value and the addition of liquid is adjusted according to the difference between the two values. In the preferred embodiment the system is used in conjunction with a laundry washing machine and is used to operate a water control valve and a soap dispenser. The sensor for measuring the viscosity and/or density is substantially as disclosed in British Patent GB-A-2236591.

**GB 2 272 454 A**

1/2



2/2



- 1 -

CONTROL SYSTEM FOR USE IN A CLEANING PROCESS

The invention relates to a control system for use in a cleaning process, in particular for use within a domestic washing machine, although it is to be understood that the invention may be used within other environments such as dishwashers or within industrial cleaning processes.

It has been proposed within a domestic washing machine to control the addition of detergent and/or rinsing water by monitoring the turbidity of the water using a cooperating light emitter and receiver. Such systems have not achieved widespread use primarily because turbidity is not necessarily related to the dirtiness of the washing water, for example, a false reading can be obtained if some dye is present. Furthermore, the sensor can soon become unreliable due to contamination of the optical surfaces.

This invention provides, in one aspect, a control system for use in a cleaning process in which a liquid cleaning agent is added to material to be cleaned, the system comprising a sensor for measuring the viscosity and/or density of liquid which has been in contact with the material, means for comparing the measured value with a

predetermined value and for adjusting the addition of liquid according to the difference between the two values.

Small amounts of, for example, dye will not substantially affect the viscosity and density of the liquid cleaning agent and so the system would not be fooled. Furthermore, sensors are available for monitoring viscosity which are essentially mechanical in operation and so are not prone to the fouling that affects optical systems.

While the invention is applicable to a cleaning process in which a cleaning agent is added having a predetermined concentration and where it is only the amount of that agent which is adjusted, it is preferred that the system further comprises means for adding a concentrated cleaning agent to a liquid solvent and for adjusting the amount of concentrated cleaning agent added according to the difference between the two values. In a preferred embodiment the control system is located within a washing machine, the solvent is water and the cleaning agent is a detergent.

It is preferred that the sensor comprises a vibratory structure, drive means for vibrating the structure and means for detecting changes in the vibration of the structure as a

result of changes in the viscosity and/or density of the liquid within which it is immersed. A suitable sensor has been described in copending patent publication GB-A-2,236,591, the contents of which are hereby incorporated into this application. In essence, that sensor comprises a tuning fork arrangement which is caused to resonate by means of piezoelectric transducers. Changes in viscosity of a fluid within which the sensor is immersed dampen the vibrations, changing the mechanical Q-factor of the resonance. The applicants have discovered that, given a known concentration of cleaning liquid, the bandwidth of the resonance changes in a predictable manner according to the amount of impurities, such as oil or earth, which are deposited in the solution. Furthermore it is also possible to predict the concentration of cleaning fluid dissolved in water by measuring either the resonant frequency or the bandwidth using such a sensor.

In another aspect the invention provides a method of cleaning by adding a liquid cleaning agent to material to be cleaned, including the steps of measuring the viscosity and/or density of agent which has been in contact with the material, comparing the measured value with a predetermined value and controlling the addition of liquid cleaning agent according to the difference between the two values.

In order that the invention may be well understood, an embodiment thereof will now be described with reference to the accompanying diagrammatic drawings, in which:-

Figure 1 shows schematically a system according to the invention installed within a domestic washing machine;

Figure 2 is a longitudinal sectional view through a sensor for use in the system shown in Figure 1; and

Figure 3 is a cross sectional view along lines A-A of Figure 2.

A washing machine 1 comprises an outermost fixed drum 2 within which a rotary drum 3 is mounted. A viscosity and density sensor 4 is located at the base of the outer drum 2 such that it projects into the annular space formed between the fixed and rotary drums 2, 3 respectively. The sensor 4 is connected to microprocessor control circuitry 5 which is itself operatively connected to a water control valve 6 for admitting water into the drum assembly 2, 3. A soap dispenser 7 is arranged to dispense soap into the water line 8 extending between the valve 6 and the drum 2, and at a rate controlled by the microprocessor 5. A pump 9 is

provided for draining away soiled water, when required, under the control of the microprocessor 5.

The sensor 4 is of similar construction to that disclosed in British Patent Publication GB-A-2,236,591, but essentially comprises a pair of closed tubes 10, 11 which extend from a circular diaphragm 12. The periphery of the diaphragm is fixed to the inner surface of a cylindrical housing 13, forming two compartments 14 and 15 separated by the diaphragm 12. Two rectangular plates 16 and 17 of a piezoelectric ceramic material are attached to the surface of the diaphragm within compartment 14. Leads 18 extend from the transducers 16, 17 and out through a pipe 19. Holes 20 are provided within the housing wall to allow fluid to flow past the tubes 10, 11. In use, application of an alternating voltage to transducer 16 causes the diaphragm 12 to bend and the free ends of tubes 10, 11 to move towards and away from each other. The other transducer 17 is operative to detect vibrations of the diaphragm 12. Changes in viscosity and density of the fluid within which the tubes 10, 11 are immersed, cause the resonant frequency of the structure and the bandwidth of that resonance to change.

The microprocessor control circuitry 5 is operative to operate the water control valve 6 and the soap dispenser 7



to discharge a predetermined volume of water and of soap into the drum 2. By measuring the change in bandwidth of the resonance of the structure 4, the amount of dirt being deposited in the cleaning solution can be determined. If, after a predetermined period of time, the level is below a preset value then no further soap need be added. If the amount of dirt and oils being deposited into the water reaches a predetermined limit, then the microprocessor control is operative to cause the machine to discharge the dirty water and admit further water and soap. These steps can be repeated at intervals throughout the wash cycle, minimising soap and water usage. Once the amount of dirt being deposited into the cleaning solution falls below a predetermined level the microprocessor control 5 is operative to drain away the soiled water and admit further water in a rinsing cycle. The state of the water within the drum can be continuously monitored so as to prevent the discharge and admission of further rinsing water when the resonance and bandwidth characteristics are similar to that of clean water. The use of this system allows the soap, for example, to be dispensed from a large storage unit which need only be filled occasionally.

Although the invention has been described with reference to a washing machine in which concentrated

detergent is added to a solvent such as water, the invention is equally applicable to other cleaning processes in which, for example, one solution only is added to the material to be cleaned, such as a dry cleaning process. The invention may also be used in other items of domestic equipment such as dishwashers or in other industrial processes where it is necessary to clean an article or material with an appropriate solution. For example in many industrial processes it is necessary to wash material, such as food stuffs, and a system according to the invention may be used within these situations as well.

CLAIMS

1. A control system for use in a cleaning process in which a liquid cleaning agent is added to material to be cleaned, comprising a sensor for measuring the viscosity and/or density of liquid which has been in contact with the material, means for comparing the measured value with a predetermined value and for adjusting the addition of liquid according to the difference between the two values.

2. A control system according to claim 1 which is operative to add a mixture of a concentrated cleaning agent and a solvent to the material to be cleaned and in which the means are operative to control the addition of both the solvent and the concentrated cleaning agent.

3. A control system as claimed in claim 1 or 2, which is located within a washing machine and in which the liquid cleaning agent comprises water and a detergent.

4. A control system as claimed in any preceding claim in which the sensor comprises a vibratory structure, drive means for vibrating the structure and means for detecting changes in the vibration of the structure as a result of

changes in the viscosity and/or density of the liquid within which it is immersed.

5. A control system as claimed in any of claims 2 to 4 which is operative to apply an initial predetermined volume and concentration of cleaning agent to the material, to monitor the amount of dirt present in the solution, and to add further cleaning agent if the concentration of dirt exceeds a predetermined level.

6. A control system substantially as described with reference to Figure 1 of the accompanying drawings.

7. A washing machine or dishwasher including a control system according to any preceding claim.

8. A method of cleaning by adding a liquid cleaning agent to material to be cleaned, including the steps of monitoring the viscosity and/or density of the liquid which has been in contact with the material, comparing the measured value with a predetermined value and controlling the addition of liquid cleaning agent according to the difference between the two values.

9. A method of cleaning substantially as described

- 10 -

with reference to Figure 1 of the accompanying drawings.

**Patents Act 1977**  
**Examiner's report to the Comptroller under Section 17**  
**(The Search report)**

- 11 -

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**Relevant Technical Fields**

- (i) UK Cl (Ed.L/M) D1A (ACA, ACC); A4F (F29A2A)  
(ii) Int Cl (Ed.5) D06F; A47L

Search Examiner  
T M JAMES

Date of completion of Search  
29 OCTOBER 1993

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-  
1-9

(ii) ONLINE DATABASES: WPI

**Categories of documents**

- X:** Document indicating lack of novelty or of inventive step.      **P:** Document published on or after the declared priority date but before the filing date of the present application.  
**Y:** Document indicating lack of inventive step if combined with one or more other documents of the same category.      **E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.  
**A:** Document indicating technological background and/or state of the art.      **&:** Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
Y	GB 2236591 A	(GEC-MARCONI) see whole document	4
X, Y	EP 0374009 A1	(ESSWIEN SA) see WPI Abstract Accession No 90-187368/25	X: 1, 3, 5, 8 at least Y: 4
X, Y	JP 3009794	(SANYO) see WPI Abstract Accession No 91-061355/09	X: 1, 3, 8 Y: 4

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).